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Relative Strength of Wet & Dry Concrete

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RELATIVE STRENGTH

OF

WET AND DRY CONCRETE

BY

RODERICK WILLIAM SILER

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

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OF Bachelor of Science in Civil Engineering.

Ira O. Baker.

HEAD OF DEPARTMENT OF Civil Engineering.

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Wet and Dry Gravel Concrete.

Concrete as a product of modern engineering needs and ingenuity. Although it has been but a few years since its first appearance, it already ranks high as a building material and the use of it is constantly increasing as its merits are becoming more widely appreciated. Because of its very general use in sewers, culverts, walls of buildings, pavement foundations and elsewhere, data concerning its strength, and information in regard to its cost and method of manufacture are of interest to the layman as well as to

the engineer.

There has been considerable discussion of late as to the relative merits of wet and dry concrete, and as there have been only a few experiments giving definite data on this subject, the writer determined to make a series of experiments to ascertain the relative strength of wet and dry gravel concrete with different degrees of tamping and of various ages. The experiments consisted in crushing six inch cubes of concrete.

With regard to the percentage of water present the concrete was designated as dry, medium, and wet. In the dry concrete just enough water was added to make the mixture workable, while with the wet concrete the

amount of water was such that it escaped from the bottom of the mold and flushed to the surface when the cubes were tamped and caused the concrete to quake. In the medium concrete the amount of water added was about an average of that in the dry and the wet.

The cubes were subjected in the process of making to two degrees of tamping, designated as heavy and light. With the former, each layer of concrete received twenty blows from a tamper weighing eleven pounds eight ounces with a face three inches square, dropped from a height of six inches. In the lightly tamped cubes ten blows were allowed to fall upon each layer. The layers were about two

an inch thick before being tamped.

The cubes were tested at three different ages, - one week, one month, and three months.

Care was taken in these experiments to make all conditions as nearly as possible similar to those met with in practice. With this object in view the materials and proportions used were those ordinarily met with in practice. The proportions were six parts of [illegible], two parts of sand, and one part cement measured by volumes without packing. Fairly clean gravel and Chicago AA Portland cement were used. After thorough mixing of the above ingredients dry, the requisite amount of water was added and the mixture was rammed into oak molds, 6"x6"x6". Particu-

Care was taken to thoroughly ram the edges of the cubes. When each mold was very nearly full of concrete, a surface of rich cement was added for two purposes- first to give the cubes a better bearing surface when being broken, and second to allow identification marks to be stamped upon the cubes.

When about one day old the cubes were removed from the molds and stored under water until of the age at which they were to be broken. The cubes were crushed in an ordinary testing machine having self adjusting parallel pressing surfaces. The stress was applied to top and bottom of cubes as made.

Tables I, II, and III show the individual results of the tests. These results are tabulated in Table IV in a form to bring out the effect of plasticity. It will be noticed that no results are given for wet concrete with heavy tamping. This is because the wet concrete became too sloppy to mold when subjected to heavy tamping. The results are presented in Table V to show the effect of age upon the strength of concrete of different degrees of plasticity and of tamping. The same results are also presented in Table VI in a way to bring out the difference between light and heavy tamping.

TABLE I.

Crushing Strength of Concrete Cubes.

Age - 1 Week.

Ref. No.	Plasticity	Amount of Tamping	Crushing Strength of 6-in. Cubes in pounds.	
			Individual Results.	Mean
1	Dry	Light	12350	
2	"	"	17800	
3	"	"	16300	15483
4	Medium	Light	22450	
5	"	"	22800	
6	"	"	24950	23400
7	Wet	Light	24700	
8	"	"	27230	
9	"	"	30930	27620
10	Dry	Heavy	23950	
11	"	"	22000	
12	"	"	20000	21983
13	Medium	Heavy	31150	
14	"	"	34930	
15	"	"	28000	31127

TABLE II

Crushing Strength of Concrete Cubes.

Age - 1 Month

Ref. No.	Plasticity	Amount of Tamping	Crushing Strength of 6-in. Cubes in Pounds	
			Individual Results	Mean.
1	Dry	Light	18500	
2	"	"	21800	
3	"	"	21300	20533
4	Medium	Light	50660	
5	"	"	54910	
6	"	"	55340	53637
7	Wet	Light	43000	
8	"	"	41450	
9	"	"	70000	51483
10	Dry	Heavy	23800	
11	"	"	27050	
12	"	"	26200	25683
13	Medium	Heavy	80000	
14	"	"	65240	
15	"	"	68240	71160

TABLE III.

Crushing Strength of Concrete Cubes.

Age - 3 Months

Ref. No.	Plasticity	Amount of Tamping	Crushing Strength of 6-in Cubes in Pounds.	
			Individual Results	Mean.
1	Dry	Light	42100	
2	"	"	43850	
3	"	"	40050	42000
4	Medium	Light	90000	
5	"	"	80250	
6	"	"	75[illegible]	82067
7	Wet	Light	71025	
8	"	"	86000	
9	"	"	89350	82125
10	Dry	Heavy	60695	
11	"	"	64000	
12	"	"	61760	62152
13	Medium	Heavy	95410	
14	"	"	92530	
15	"	"	98920	[illegible]

TABLE IV.

Effect of Age upon Strength of Concrete.

Ref. No.	Plasticity.	Amount of Tamping	Crushing Strength.		
			6-in. cubes. Pounds.	Pounds per square inch.	Tons per square foot.
			Age - 1 Week.		
1	Dry	Light	15483	430	30.97
2	Medium	"	23400	650	46.80
3	Wet	"	27620	767	55.24
4	Dry	Heavy	21983	612	43.97
5	Medium	"	31127	865	62.25
		Average	23923	665	47.85
			Age - 1 Month		
1	Dry	Light	20533	570	41.06
2	Medium	"	53637	1490	107.27
3	Wet	"	51483	1430	102.97
4	Dry	Heavy	25683	714	51.37
5	Medium	"	71160	1977	142.32
		Average	44499	1236	89.00
			Age - 3 Months.		
1	Dry	Light	42000	1167	84.00
2	Medium	"	82067	2279	164.02
3	Wet	"	82125	2281	164.25
4	Dry	Heavy	62152	1726	124.30
5	Medium	"	95620	2656	191.24
		Average	72793	2022	145.56

TABLE V.

Effect of Tamping upon Strength of Concrete.

Ref. No.	Plasticity.	Age	Crushing Strength. 6-in. cubes. Pounds.	Pounds per square inch.	Tons per square foot.
			Light Tamping.		
1	Dry	1 Week	15483.	430	30.97
2	Medium	" "	23400	650	46.80
3	Wet	" "	27620	767	55.24
4	Dry	1 Month	20533	570	41.06
5	Medium	" "	53637	1490	107.27
6	Wet	" "	51483	1430	102.97
7	Dry	3 Month	42000	1167	84.00
8	Medium	" "	82067	2279	164.02
9	Wet	" "	82125	2281	164.25
		Average	44261	1229	88.51
			Heavy Tamping		
1	Dry	1 Week	21983	612	43.97
2	Medium	" "	31127	865	62.25
3	Dry	1 Month	25683	714	51.37
4	Medium	" "	71160	1977	142.32
5	Dry	3 Month	62152	1726	124.30
6	Medium	" "	95620	2656	191.24
		Average	51288	1425	102.58

TABLE VI.

Effect of Plasticity upon Strength of Concrete.

Ref No.	Age.	Amount of Tamping	Crushing Strength. 6-in. cubes Pounds	Pounds per square inch.	Tons per square foot.
			Plasticity - Dry		
1	1 Week	Light	15483	430	30.97
2	" "	Heavy	21983	612	43.97
3	1 Month	Light	20530	570	41.06
4	" "	Heavy	25683	714	51.37
5	3 Month	Light	42000	1167	84.00
6	" "	Heavy	62152	726	124.30
	Average		31305	870	62.61
			Plasticity - Medium.		
1	1 Week	Light	23400	650	46.80
2	" "	Heavy	31127	865	62.25
3	1 Month	Light	53637	1490	107.27
4	" "	Heavy	71160	1977	142.32
5	3 Month	Light	82067	2279	164.02
6	" "	Heavy	95620	2656	191.24
	Average		59502	1653	118.98
			Plasticity - Wet		
1	1 Week	Light	27620	767	55.24
2	1 Month	"	51483	1430	102.97
3	3 Month	"	82125	2281	164.25
			53743	1493	107.49

Conclusions.

The form of presentation in Tables IV, V, and VI is such as not to require much comment.

Table IV shows the strength of concrete composed of one part Portland cement, two parts sand, and four parts gravel to be 665 pounds per square inch at one week; 1236 pounds per square inch at one month; and 2022 pounds per square inch at three months.

Table V shows the effect of light and heavy tamping for all degrees of plasticity, and appears to indicate that the heavy tamping gives nearly twenty per cent greater strength

than the light tamping, but it should be noticed that wet concrete is included under light tamping, while it is not included under heavy tamping; but separating the two degrees of plasticity and taking a mean shows that the increased tamping adds substantially twenty per cent to the strength.

Table VI shows the effect of water on the strength of concrete. The average strength of the dry concrete is for light tamping 722 pounds per square inch, and for heavy tamping 924 pounds per square inch; for the medium concrete 1473 pounds per square inch for light tamping, and for heavy tamping 1827 pounds per square

inch; for the wet concrete with which only light tamping was used 1493 pounds per square inch. The medium mixture is practically twice as strong as the dry mixture.

The final conclusion is that it is best to use a medium mixture with heavy tamping.

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